University of Badji-Mokhtar Annaba
Faculty of Technology
Department 2 nd year (2025-2026)

Exam Solutions in mineral chemistry

Exercise 1 (3pts)

1. The name of each stage of sulfuric acid production:
   1- COMBUSTION **0.5**
   2- CATALYTIC OXIDATION **0.5**
   3- ABSORPTION **0.5**
   4- DILUTION **0.5**

2. Application of sulfuric acid in industry: **1**
used to manufacture fertilizers such as ammonium sulfate and calcium phosphate.

Exercise 2 (7pts)

I. **The following lattice planes (Miller indices (hkl)). The unit cells are cubic.** **1x4**

1	2	3	4
a= 1 h= 1 b= 1 k= 1 c= 1 l= 1 plane (1 1 1)	a= ∞ h= 0 b= 1 k= 1 c= ∞ l= 0 plane (0 1 0)	a= 1 h= 1 b=1 k= 1 c=-1 l= $\bar{1}$ plane (1 1 $\bar{1}$)	a= 1/2 h= 2 b= ∞ k= 0 c= 1 l= 1 plane (2 0 1)

II.

1. Calculate the mass density (ρ) of the Fe–Ni alloy.

$$\rho = \frac{z.M_{\text{Fe-Ni alloy}}}{N_A V_{\text{unit cell}}} \quad \textbf{0.5}$$

$$M_{\text{Fe-Ni alloy}} = 0{,}8\, M_{Fe} + 0{,}2 M_{Ni}$$

$$M_{\text{Fe-Ni alloy}} = 0{,}8 \times 55{,}85 + 0{,}8 \times 58{,}69$$

$$M_{\text{Fe-Ni alloy}} = 56{,}42 g/mol \quad \textbf{0.25}$$

$$V_{maille} = a^3$$

$$\rho = \frac{2 \times 56{,}85 \times 10^{-3}}{6{,}023 \times 10^{23} (2{,}86 \times 10^{-10})^3}$$

$$\rho = 8009{,}56\ Kg/m^3 \quad \textbf{0.25}$$

2. Calculate the packing factor (C) for the Fe–Ni alloy.

$$C = \frac{V_{\text{occupied by atoms in the unit cell}}}{V_{\text{unit cell}}} \quad \textbf{0.5}$$

$$C = \frac{z.\frac{4}{3}\pi r^3_{\text{Fe-Ni alloy}}}{N_A V_{\text{unit cell}}}$$

$$r_{\text{Fe-Ni alloy}} = 0{,}8\, r_{Fe} + 0{,}2 r_{Ni}$$

$$r_{\text{Fe-Ni alloy}} = 0{,}8 \times 1{,}24 + 0{,}2 \times 1{,}25$$

$$r_{\text{Fe-Ni alloy}} = 1{,}24\ A° \quad \textbf{0.25}$$

$$V_{\text{unit cell}} = a^3$$

$$C = \frac{2 \times \frac{4}{3} \times 3{,}14 \times (1{,}24 \times 10^{-10})^3}{2{,}34 \times 10^{-29}}$$

$$C = 0{,}686 \qquad \textbf{0.25}$$

3. Calculate the packing rate (τ) for the Fe–Ni alloy.

$$\tau = C \times 100 \qquad \textbf{0.5}$$

$$\tau = 0{,}682 \times 100$$

$$\tau = 68{,}6\% \qquad \textbf{0.5}$$

Exercise 3 (5pts)

1. the nature of the bonds between the Na^+ and Cl^- ions **ionic**. **1**

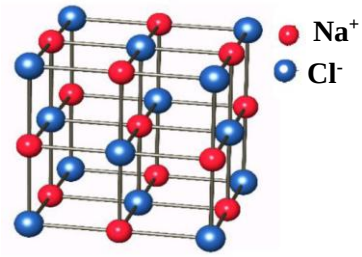
2. Representation of the unit cell:

Since r^+=0.102 nm pm < r^-= 0.181 nm , the **Cl^- ions occupy the corners of the cube and center of face in the cube**, **the Na^+ ions occupy the crystallographic sites** **1**

Calculation of the radius ratio: **0.5**

$$\frac{r^+}{r^-} = \frac{0.102}{0.181} = 0{,}565$$

$$0.414 < \frac{r^+}{r^-} < 0{,}732 \qquad \textbf{0.5}$$



According to **Pauling's rules**, the crystal site of Na^+ is **Ocrahedral**. **1**

3. Coordination number (CN) of ions:

- For Cl^-: : Cl^- / Na^+= 6 **0.5**
- For Na^+: Na^+/Cl^- = 6 **0.5**

Exercise 4 (5pts)

1. Position in the periodic table (column, period, group):

$_{9}$**F** $1s^2 2s^2 2p^5$ **0.25**

Period: 2 **0.25**

Group: VII_A **0.25**

Column: 17 **0.25**

$_{13}$**Al:** $1s^2 2s^2 2p^6 3s^2 3p^1$ **0.25**

Period: 3 **0.25**

Group: III_A **0.25**

Column: 13 **0.25**

$_{17}$**Cl:** $1s^2 2s^2 2p^6 3s^2 3p^5$ **0.25**

Period: 3 **0.25**

Group: VII_A **0.25**

Column: 17 **0.25**

2. Classification of these elements in increasing order, with respect to:

a. ionization energy

$$Al < Cl < F \qquad \textbf{0.25}$$

b. atomic radius

$$F < Cl < Al \qquad \textbf{0.25}$$

3. Identify the element in the periodic table:

- An element is located in the 4th period: n=4
- the same group as Al = They have the same valence shell. (ns^2np^1)

The valence shell f this element is $4s^24p^1$

$1s^22s^22p^63s^23p^63d^{10}4s^24p^1$ **0.5**

Z= 31

The element is Ga **0.5**

4. Applications of fluorine (F) and chlorine (Cl):

- **Fluorine (F): 0.25**

Fluorine is used in toothpaste in the form of fluoride compounds to strengthen tooth enamel and prevent dental caries.

- **Chlorine (Cl): 0.25**

Used in Disinfection of drinking water and swimming pools.